**6560-50-P**

**ENVIRONMENTAL PROTECTION AGENCY**

**40 CFR Part 194**

**[EPA-HQ-OAR-2019-0534; FRL-9737-01-OAR]**

# Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the Disposal Regulations: Recertification Decision

**AGENCY:** Environmental Protection Agency (EPA).

**ACTION:** Notification of recertification decision.

**SUMMARY:** The Environmental Protection Agency (EPA or the Agency) recertifies that the U.S. Department of Energy's (DOE or the Department) Waste Isolation Pilot Plant (WIPP) continues to comply with the final disposal regulations, known as the "Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste." This is the fourth periodic evaluation of the WIPP's continued compliance with the disposal regulations and WIPP Compliance Criteria. The WIPP Compliance Criteria implement and interpret the disposal regulations specifically for the WIPP. This recertification process is required every five years. This recertification decision is based on a thorough review of information submitted by DOE, independent technical analyses and public comments. The Agency has determined that DOE continues to meet all applicable requirements of the final disposal regulations and the WIPP Compliance Criteria and recertifies the WIPP facility. EPA has also identified areas in which the DOE's technical analyses and justifications could be improved for the next recertification application.

**DATES:** [INSERT DATE OF PUBLICATION IN THE FEDERAL REGISTER].

**FOR FURTHER INFORMATION CONTACT:** Ray Lee, Radiation Protection Division, Mail Code 6608T, U.S. Environmental Protection Agency, 1200 Pennsylvania Avenue, Washington,

DC, 20460; telephone number: 202-343-9463; e-mail address: lee.raymond@epa.gov. Copies of the Compliance Application Review Documents (CARDs) supporting this action and all other recertification-related documentation can be found in the Agency's electronic docket found at *https://www.regulations.gov* (Docket ID No. EPA-HQ-OAR-2019-0534).

**SUPPLEMENTARY INFORMATION:**

**Table of Contents**

**Abbreviations**

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| Am | Americium |
| APCS | Abandonment of Panel Closures in the South |
| CARD | Compliance Application Review Document |
| CCA | Compliance Certification Application |
| CFR | Code of Federal Regulations |
| CRA | Compliance Recertification Application |
| DOE | U.S. Department of Energy |
| EPA | U.S. Environmental Protection Agency |
| FR | Federal Register |
| KPLA | Known Potash Leasing Area |
| LWA | Land Withdrawal Act |
| OAR | Office of Air and Radiation |
| Pa | Pascal |
| PA | Performance Assessment |
| Pu | Plutonium |
| TRU | Transuranic |
| TSD | Technical Support Document |
| WIPP | Waste Isolation Pilot Plant |

## I. General Information

*How Can I Get Copies of This Document and Other Related Information?*

EPA has established a docket for this action under Docket ID No. EPA-HQ-OAR-2019-0534. Publicly available docket materials are available either electronically at *https://www.regulations.gov* or in hard copy at the Air and Radiation Docket in the EPA Docket Center, (EPA/DC) EPA West, Room B102, 1301 Constitution Ave., NW, Washington, DC. Due to public health concerns related to COVID-19, the EPA Docket Center and Reading Room are open to the public ***by appointment only***, and walk-ins are not allowed. Visitors to the Reading Room must complete docket material requests in advance and then make an appointment to retrieve the material. Please contact the EPA Reading Room staff at (202) 566-1744 or via e-mail at *docket-customerservice@epa.gov* to arrange material requests and appointments. Hand deliveries and couriers may be received by scheduled appointment only. For further information on EPA Docket Center services and status, please visit us online at *https://www.epa.gov/dockets*.

EPA inspection or audit reports are routinely published on the Agency's WIPP website *https://www.epa.gov/radiation/epas-role-waste-isolation-pilot-plant-wipp* and WIPP-NEWS e-mail listserv.

## II. What is the WIPP?

The WIPP is a disposal system developed specifically, and exclusively, for defense-related transuranic (TRU) radioactive waste, operated by the U.S. Department of Energy (DOE) and located near Carlsbad in southeastern New Mexico. TRU waste is material containing alpha emitting radioisotopes, with half-lives greater than twenty years, in concentrations greater than 100 nanocuries per gram (nCi/g). WIPP Land Withdrawal Act (LWA), Pub. L. 102-579 (October 30, 1992), section 2(18). This waste primarily consists of clothing, tools, rags, residues, research material, sludges, debris, soil and other items contaminated with small amounts of plutonium (Pu) and other man-made radioactive elements. At the WIPP, DOE disposes of radioactive waste approximately 655 meters (2,150 feet) underground in an ancient salt layer which will eventually

creep, encapsulate, and isolate the waste. Under LWA section 7(a)(3), the WIPP has a total statutory capacity of 175,570 cubic meters (6.2 million cubic feet) of TRU waste.

The LWA provides EPA the authority to oversee and regulate the WIPP. Pursuant, in part, to such authority, EPA promulgated or revised the Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes, 40 CFR part 191,[1] and the "Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance With the 40 CFR Part 191 Disposal Regulations" and 40 CFR part 194 (the WIPP Compliance Criteria).[2] The LWA directs DOE every five years to demonstrate continued compliance with the disposal regulations, and, after receipt of the submission from DOE, EPA determines whether the WIPP continues to be in compliance.[3] The WIPP Compliance Criteria make further provisions relating to the periodic (every five years) recertification of the WIPP.[4] EPA's determination published in this document is for DOE's fourth periodic recertification.

## III. Compliance Certification History

### *A. 1998 Certification Decision*

LWA section 8(d) required EPA to conduct an initial compliance evaluation of the WIPP and to certify whether the WIPP facility will comply with the final disposal regulations. On May 18, 1998, EPA conditionally certified that the WIPP will comply with the disposal regulations. *See* 63 FR 27354. The complete record and basis for the EPA's 1998 certification decision can be found in Air Docket A-93-02.

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[1] *See* 50 FR 38066 (September 19, 1985) and 58 FR 66398 (December 20, 1993).

[2] *See* 61 FR 5224 (February 9, 1996).

[3] LWA, section 8(f).

[4] Since EPA's initial certification, the operation of the WIPP proceeded without substantial interruption until 2014. However, two events took place at the WIPP in February 2014 that led DOE to suspend the emplacement of additional waste in the facility for nearly three years. Refer to the prior recertification document (82 FR 33106, July 19, 2017) for more information.

*B. Previous Recertification Decisions*

Subsequent to EPA's 1998 initial compliance certification of the WIPP, DOE periodically (every five years) has submitted, as required by the LWA, documentation of continued compliance, and EPA previously recertified the WIPP on three separate occasions. EPA's first WIPP recertification decision was announced on April 10, 2006 (*see* 71 FR 18010); the second on November 18, 2010 (*see* 75 FR 70584); and the third on July 19, 2017 (*see* 82 FR 33106).

## IV. WIPP Compliance with Radioactive Waste Disposal Regulations and the WIPP Compliance Criteria

The WIPP must comply with EPA's radioactive waste disposal regulations, located at subparts B and C of 40 CFR part 191 (referred to as the "final disposal regulations" in LWA sections 8(d) and (f)). These regulations limit the amount of radioactive material which may escape from a disposal facility to protect individuals and groundwater resources from dangerous levels of radioactive contamination.

DOE submits a Compliance Recertification Application (CRA) every five years to demonstrate compliance with 40 CFR parts 191 and 194 per LWA section 8(f). Compliance applications must demonstrate compliance with the requirements contained within each section of 40 CFR part 194[5] and provide a comprehensive, technically justified assessment of repository performance demonstrating compliance with 40 CFR part 191, subparts B and C (through a

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[5]To some extent, the discussion in this *Federal Register* document describing EPA's evaluation of CRA-2019 tracks the various requirements or sections of 40 CFR part 194. So, for example, Section IV.B of this document relates to certain conditions associated with EPA's basic certification of compliance for the WIPP, as set out in part 194, App. A.; Section VI.C of this document substantially relates to requirements associated with §§194.14, 194.15, 194.23, and 194.31 through 194.34. This organization, though, is not strict and there is some overlap and intersection among the subparagraphs of Section VI.C of this document and the various requirements of part 194 (and part 191). In addition, the provisions of some sections of part 194 require little, if any, discussion. So, for example, DOE did not conduct any activities during the period covered by this CRA related to future states assumptions (§194.25), expert judgment (§194.26), or assurance requirements (§§194.41 through 194.46). See the corresponding CARDs for more discussion.

process known as "performance assessment"). Upon receiving the CRA from DOE, EPA first makes a completeness determination by performing an in-depth review to ensure DOE's submission is sufficiently detailed to support EPA's technical evaluation with respect to all compliance criteria. EPA finishes its technical evaluation after DOE responds to EPA's completeness comments and EPA considers the CRA complete (40 CFR 194.11).

DOE's WIPP compliance applications must include, at a minimum, basic information about the WIPP site and disposal system design, including information about the following topics: the geology, hydrology, hydrogeology and geochemistry of the WIPP disposal system and the WIPP vicinity; the WIPP materials of construction; standards applied to design and construction; background radiation in air, soil and water; and past and current climatological and meteorological conditions (40 CFR 194.14). Section 194.15 states that DOE's recertification applications shall update this information to provide sufficient information for EPA to determine whether the WIPP facility continues to be in compliance with the disposal regulations.

In addition, the WIPP must comply with the WIPP Compliance Criteria at 40 CFR part 194. The WIPP Compliance Criteria implement and interpret the general disposal regulations specifically for the WIPP and clarify the basis and process by which EPA makes certification and recertification decisions.[6]

*A. How Does EPA Ensure Ongoing Compliance with the WIPP Compliance Criteria?*

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[6] In addition to EPA's radioactive waste disposal regulations and the WIPP Compliance Criteria, the WIPP must also comply with a number of other Federal laws and regulations pertaining to public health and safety or the environment. *See, for example*, LWA section 9. In a separate process, distinct from this periodic (every five years) compliance recertification process, DOE also must periodically (every two years) submit documentation of continued compliance with such other laws and EPA (or the State of New Mexico, as appropriate) must, in response, determine whether the WIPP is in compliance with such laws. The most recent Biennial Environmental Compliance Report (BECR) determination for the WIPP, dated 04/13/2021, may be found at Docket ID No. EPA-HQ-OAR-2001-0012-0701.

In addition to the periodic recertification process, EPA, on an on-going basis, monitors and ensures continuing compliance with EPA regulations through a variety of activities, including the following: review and evaluation of DOE's annual change reports, monitoring the conditions of compliance, addressing planned change requests, information requests concerning the WIPP, inspections of the WIPP site, and inspections of waste characterization operations. The Agency has conducted periodic inspections to verify the adequacy of information relevant to certification applications. EPA conducts inspections at the WIPP site to review and ensure that the monitoring program meets the requirements of §194.42. EPA has also inspected the emplacement and tracking of waste in the repository. The Agency's inspection reports can be found in Air Docket A-98-49, Categories II-A1 and II-A4, as well as online at https://www.regulations.gov, Docket ID No. EPA-HQ-OAR-2001-0012.

DOE must report any planned or unplanned changes in activities or conditions pertaining to the disposal system that differ significantly from the most recent compliance application and, at least annually, report any other changes in disposal system conditions or activities. 40 CFR 194.4(b)(3), (4). DOE must also report any releases of radioactive material from the disposal system. 40 CFR 194.4(b)(3)(iii). DOE's annual change reports reflect the progress of quality assurance and waste characterization inspections, minor changes to DOE documents, information on monitoring activities, and any additional EPA approvals for changes in activities. In addition, EPA may request additional information from DOE (*see, for example,* 40 CFR 194.4(b)(2)). These requirements assist EPA with monitoring the performance of the disposal system and evaluating whether the certification should be modified, suspended or revoked. All correspondence and approvals regarding the annual change reports can be found in hard copy in the Air Docket A-98-49, Categories II-B2 and II-B3, and also in Docket ID No. EPA-HQ-OAR-2001-0012 at *https://www.regulations.gov*.

*B. Compliance Certification Conditions*

In connection with the compliance criteria, there also are four conditions of compliance described in 40 CFR part 194, appendix A, that must be met. Below are brief descriptions of each condition and any changes made by DOE since the last CRA to meet those conditions.

1. Panel Closure System

Certification Condition 1 states that DOE shall close filled waste panels in a manner that has been specifically approved by EPA. The WIPP waste panel closure system design changed between the 2014 recertification application and this 2019 recertification following the February 2014 radiological release that contaminated the south end of the repository.[7] The run-of-mine salt closures planned for panels 3-6 could not be emplaced and panel 9 was abandoned due to safety concerns. Because access to panels 3-6 was through panel 9, DOE installed run-of-mine salt closures and steel bulkheads in the access drifts to panel 9 to block personnel access to the south end waste panels, which the Agency verified in an May/August 2019 inspection (Docket ID No. EPA-HQ-OAR-2001-0012-04700). The closure system design for panels 1, 2, 7, 8 and 10 consisting of run-of-mine salt closures and steel bulkheads were not changed by the accidental release.

2. Quality Assurance

Certification Condition 2 requires waste generator sites to establish and execute a quality assurance program for waste characterization activities. Section 194.22 establishes quality assurance requirements for the WIPP. DOE must adhere to a quality assurance program that implements the requirements of ASME NQA-1-1989 edition, ASME NQA-2a-1990 addenda, part 2.7, to ASME NQA-2-1989 edition, and ASME NQA-3-1989 edition (excluding Section 2.1 (b) and (c), and Section 17.1). EPA determined that the CRA-2019 provides adequate information to verify the establishment and implementation of a quality assurance program in

[7] For a discussion of the 2014 incidents at the WIPP, *see* EPA's prior recertification determination. 82 FR 33106, 33107 (July 19, 2017).

accordance with ASME NQA-1-1989 through periodic audits conducted in accordance with §194.22(e). EPA's determination of compliance with 40 CFR 194.22 can be found in Table 1 of CARD 22. Between March 2014 and March 2019, EPA conducted several quality assurance audits and found the site-specific quality assurance programs to be adequate. Records of EPA's quality assurance correspondences and waste characterization approvals can be found in Air Docket A-98-49, Categories II-A1 and II-A4, respectively, as well as online in Docket ID No. EPA-HQ-OAR-2001-0012 on *https://www.regulations.gov*.

3. Waste Characterization

Certification Condition 3 requires waste generator sites to have waste characterization systems approved by EPA. DOE implemented site-specific waste characterization programs to (a) characterize physical and radiological components in individual waste containers; and (b) demonstrate compliance with the WIPP waste disposal requirements at 40 CFR 194.24 and 194.8. Since the last recertification (CRA-2014), EPA conducted inspections of various site-specific waste characterization programs and requests for changes in accordance with 40 CFR 194.24 and 194.8 and concluded they were technically adequate (*see* Table 1 in CARD 8 and CARD 24 for further details). During the period covered by CRA-2019, all site-specific waste characterization systems of controls at active waste generator sites had necessary baseline approvals.

4. Passive Institutional Controls

While DOE provided information on potential passive institutional control designs at the time of the certification, Certification Condition 4 requires DOE to submit a schedule and plan for implementing passive institutional controls, including markers and other measures indicating the presence of the repository, but DOE is not required to provide such information until the final CRA prior to the closure of the WIPP. EPA anticipates that it will evaluate DOE's compliance with Condition 4 of the certification when DOE submits a revised schedule and additional

documentation regarding the implementation of passive institutional controls. EPA has not received any submissions from DOE during the period addressed by CRA-2019 and has not taken any actions relating to Condition 4 (*see* CARD 43).

## V. The 2019 CRA

### *A. DOE's 2019 CRA*

On March 26, 2019, DOE submitted the most recent CRA as required by 40 CFR 194.15(a), updating its previous 2014 submission. On September 25, 2019, EPA gave public notice of DOE's submittal of CRA-2019 and opened the official public comment period (84 FR 50367). On December 20, 2019, DOE submitted a performance assessment (PA) and supporting documentation. This deferred PA was previously agreed upon by EPA and DOE so that the Department could address technical issues identified in the previous CRA. EPA submitted to DOE six (6) letters with questions that DOE responded to between June 2020 to June 2021, with 2 additional sets of follow up questions communicated through email. This information supplements the documentation DOE submitted in March and December 2019. On November 17, 2021, EPA sent a letter to DOE stating that DOE's recertification application was complete. On November 26, 2021, EPA issued a *Federal Register* document announcing the completeness determination and stating that the public comment period would close on December 27, 2021. *See* 86 FR 67424. The CRA-2019 completeness-related correspondence can be found in the WIPP public docket at Docket ID No. EPA-HQ-OAR-2019-0534 at *https://www.regulations.gov*.[8]

[8] In accordance with 40 CFR 194.67, EPA maintains public dockets via *https://www.regulations.gov* that contain all the information used to support the Agency's decision on recertification. The Agency maintains the formal docket in Washington, D.C., as well as informational legacy/paper dockets related to the original certification decision (R-89-01, A-92-56, and A-93-02) in three locations in the State of New Mexico (Carlsbad, Albuquerque, and Santa Fe). The docket as a whole consists of all relevant, significant information received to date from outside parties and all significant information considered by EPA in reaching a WIPP recertification decision.

Since September 2019, EPA has published and disseminated numerous announcements regarding the recertification schedule and availability of WIPP-related documents on the EPA WIPP website and the dockets.[9] EPA held an on-line, or virtual, informal stakeholder meeting on August 17, 2021, to allow additional opportunity for public participation during the recertification process (see the EPA WIPP website for slides and documents from the informal meeting). The meeting consisted of one three-hour evening session to allow for time-zone differences between headquarters in Washington, DC and stakeholders in New Mexico. To make this meeting informative to all attending parties, EPA listened to stakeholder input and concerns and tailored the meeting around the public as much as possible.[10]

The main purpose of the stakeholder meeting was to provide information and further opportunity to address questions about EPA's recertification process and timeline, as well as DOE's application and important changes at the WIPP since the last recertification in 2017. The meeting featured brief EPA presentations followed by a question-and-answer session. In response to stakeholder suggestions, DOE staff members were also on hand to provide information and respond to stakeholder questions related to DOE's application and current WIPP activities. Staff from the New Mexico Environment Department attended as observers. Public participants were encouraged to provide comments to EPA for consideration during the review

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[9] A variety of general information, pertinent new information, and updates on EPA's WIPP activities is available at the WIPP internet homepage at *https://www.epa.gov/radiation/epas-role-waste-isolation-pilot-plant-wipp*. All pertinent recertification-related documents (including the DOE-submitted recertification materials, letters, Federal Register notices, outreach materials, etc.) are available for review or download (in Adobe PDF format) via the electronic docket dedicated to the 2019 recertification process (*https://www.regulations.gov*, Docket ID No. EPA-HQ-OAR-2019-0534). The Agency's WIPP-NEWS e-mail listserv, which automatically sends messages to subscribers with up to date WIPP announcements and information, is also available online. Any individuals wishing to subscribe to the listserv can join by visiting *https://lists.epa.gov/read/all_forums/subscribe?name=wipp-news* and providing all requested information to register.

[10] Although EPA has provided opportunities for public engagement, including a virtual meeting and an opportunity to comment, under section 8(f)(2) of the LWA, the periodic (every five years) recertification of the WIPP and EPA's recertification determination are not subject to rulemaking. In accordance with the LWA, EPA is not and has not engaged in rulemaking in connection with its recertification determination and did not intend to do so simply by seeking and providing opportunity for public participation.

of DOE's CRA-2019. The issues raised at this virtual meeting have been considered and addressed by EPA in this document and within the CARDs, which are available in the public recertification docket. EPA received 11 substantial public comments and has considered and appropriately responded to those comments. *See* Appendix 15-B of CARD 15.

*B. EPA Evaluation of the 2019 CRA*

This EPA recertification decision is based on the entire record compiled by the Agency, which is available in the public docket dedicated to this recertification (Docket ID No. EPA-HQ-OAR-2019-0534 at *https://www.regulations.gov*). The record consists of the CRA-2019, supplementary information submitted by DOE in response to EPA requests, technical reports generated by EPA, EPA audit and inspection reports, documentation from technical exchanges between EPA and DOE staff to better understand some of DOE's responses to requests for additional information, independent EPA calculations, and comments submitted on DOE's application and EPA's completeness review during the public comment period. All pertinent CRA-2019 correspondence was placed in the public recertification docket and linked on EPA's WIPP recertification website *https://www.epa.gov/radiation/certification-and-recertification-wipp*.

The focus of EPA's technical review relating to the CRA-2019 was on topical areas identified by DOE and confirmed by EPA as having been changed since the CRA-2014 (*see* Section VI of this document for further discussion of EPA's technical review). EPA produced multiple documents during the technical review and evaluation of the CRA. These documents included CARDs along with technical support documents (TSDs).[11] Together, EPA's completeness

[11] The CARDs discuss DOE's compliance with each of the individual requirements of the WIPP Compliance Criteria and correspond in number to the sections of 40 CFR part 194 to which the documents primarily relate. Each CARD reviews the changes made by DOE and describes EPA's evaluations and conclusions. The CARDs also list the EPA TSDs and any other references used by EPA. For more detailed information on the technical issues

comments, CARDs, and TSDs thoroughly document EPA's review of DOE's CRA-2019 and the technical basis for the Agency's decisions. In addition, EPA used DOE performance assessment computer codes to independently investigate the impact (i.e., sensitivity) of parameter changes on the calculated releases from the repository. The results of these sensitivity calculations are discussed in Section VI.E of this document and in Section 4.0 of the EPA TSD *Overview of EPA Review of U.S. Department of Energy 2019 WIPP Compliance Recertification Application Performance Assessment* (Docket ID No. EPA-HQ-OAR-2019-0534).

### *C. EPA's 2019 Recertification Decision*

In response to the CRA-2019 and after consideration of all the materials and information described in this document, EPA determines, in accordance with LWA section 8(f)(2), that the WIPP facility is in compliance with the final disposal regulations, subparts B and C of 40 CFR part 191. The calculated releases contained in the PA demonstrate that the WIPP will not exceed regulatory limits on releases of radionuclides to the accessible environment[12] during the 10,000-year performance period. Compliance recertification ensures that accurate and up-to-date information is considered in the determination that WIPP remains in compliance with these radioactive waste disposal regulations. EPA makes this recertification and determination of continued compliance following the "Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance With the 40 CFR part 191 Disposal Regulations" (WIPP Compliance Criteria, 40 CFR part 194), including the WIPP certification conditions (40 CFR part 194, appendix A). The Agency's review has also identified instances where aspects of the PA could be enhanced or improved, most notably in connection with the geochemistry

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considered in EPA's recertification decision, see the TSDs. All CARDs, TSDs, and references are available in the public recertification docket, via Regulations.gov (Docket ID No. EPA-HQ-OAR-2019-0534), with the exception of generally available references and those documents already maintained by DOE or its contractors in locations accessible to the public.

[12] The accessible environment is defined in 40 CFR 191.12 as (1) The atmosphere: (2) land surfaces; (3) surface waters; (4) oceans; and (5) all of the lithosphere that is beyond the controlled area.

database. The results of EPA's review of the CRA-2019, including descriptions of EPA's review process, expanded discussions of selected topics of interest, and supplemental confirmatory modeling carried out by EPA staff, are contained in Section VI of this document.

## VI. EPA's Technical Review

### *A. Performance Assessment and EPA Standards*

The disposal regulations at 40 CFR part 191 include requirements for the containment of radionuclides. The numerical containment requirements at 40 CFR 191.13 specify that releases of radionuclides to the accessible environment must be unlikely to exceed specific limits for 10,000 years after disposal. As noted previously, DOE assesses the likelihood that the WIPP will meet these release limits through a performance assessment.

The disposal regulations provide that there must be a reasonable expectation that cumulative releases of radionuclides from the WIPP and into the environment over 10,000 years will not exceed specified quantities of these radionuclides (40 CFR 191.13 and appendix A). A reasonable expectation standard is used because of the long time period involved and because the nature of the events and processes at radioactive waste disposal facilities lead to uncertainties about future performance. DOE's probabilistic performance assessments calculate the likelihood of an environmental radionuclide release by accounting for future uncertainties through the use of alternative scenarios and variations in values of uncertain parameters via probability distributions.

The containment requirements in 40 CFR 191.13 are expressed in terms of "normalized releases." At the WIPP, the specific release limits are based on the estimated amount of waste in the repository at the time of closure, and the projected releases are "normalized" against these limits (§194.31). Normalized releases are expressed as "EPA units."

DOE must demonstrate, in each CRA, that the total average of combined releases is below two compliance criteria at a higher probability of occurrence and a lower probability of occurrence. These probability compliance points are as follows:

1. For a probability of 0.1 (a 1 in 10 chance) in 10,000 years, cumulative releases to the accessible environment will not exceed 1 EPA unit, and

2. For a probability of 0.001 (a 1 in 1,000 chance) in 10,000 years, cumulative releases to the accessible environment will not exceed 10 EPA units.

In the undisturbed case, that is if there is no drilling into the repository, no releases are expected as the salt will isolate the waste very effectively. For the disturbed case, DOE evaluates four release mechanisms in the WIPP performance assessment modeling:

*Cuttings and cavings.* These consist of waste material that gets brought to the surface when a borehole intersects waste in a WIPP waste panel. Cuttings are waste materials intersected by the borehole itself and cavings are waste materials that fail around the borehole, collapse into it, and are brought to the surface.

*Spallings.* These are the solid materials that fail and are brought to the surface under high-pressure conditions in the repository. This only occurs when the pressure is above 8 megapascals[13] (MPa).

*Direct Brine Releases.* These are releases of dissolved actinides in brine when the pressure in the repository is high (i.e., above 8 MPa) and brine saturations are above residual saturation (i.e., brine is not "trapped" between pore spaces) through a borehole that intersects a waste panel. The contaminated fluid is brought to the surface over a period of hours to days.

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[13] "Pascal" is a unit of pressure, defined as 1 kg/m-sec$^2$. A megapascal is one million pascals.

*Releases to the Culebra.* These occur when contaminated brine from the repository is introduced via a borehole to the Culebra Dolomite (a geological unit, stratum or layer) and then moves to the edge of the accessible environment.

DOE estimates the potential cumulative releases from these release mechanisms and compares them with the specified limits provided in Table 1 of 40 CFR part 191, appendix A. DOE is to provide in the application overall mean calculated releases and the upper 95$^{th}$ confidence limit of that mean.

*A. Status of EPA Identified Areas for Improvement from the 2017 Recertification Decision*

1. Plutonium Oxidation States

Since the original Compliance Certification Application (CCA), WIPP Pu solubility calculations have assumed a 50/50 split between aqueous Pu(IV) in equilibrium with solid Pu(IV) and aqueous Pu(III) in equilibrium with solid Pu(III). There is growing evidence in the published scientific literature that suggests the chemical conditions at the WIPP will favor Pu(III) over other oxidation states. Pu(III) has a higher solubility than Pu(IV), and the preference for Pu(III) over Pu(IV) results in higher calculated releases under the direct brine release scenario. EPA flagged this issue in its review of CRA-2014 and the Agency now considers the case to be stronger for the dominance of Pu(III), as documented in EPA's independent literature evaluation and modeling study on Pu oxidation states at the WIPP[14] that concluded that conditions at the repository will overwhelmingly support Pu(III) over Pu(IV). Pending more robust technical justification for its current or an alternative approach, DOE should assume Pu(III) solids control dissolved Pu concentrations in future PA calculations.

2. Geochemistry Database

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[14] Schramke, J.A., E.F.U. Santillan, R.T. Peake, "Plutonium Oxidation States in the Waste Isolation Pilot Plant Repository," Applied Geochemistry, 116:104561, 2020.

In its 2017 recertification decision, EPA noted multiple technical issues in the geochemistry database that is used to calculate actinide solubility, many of which were to be addressed in the CRA-2019 (e.g., organic ligands, iron, and lead). DOE has provided updates to address these issues. *See* Section VI.D.1 of this document for more details.

3. Microbial Colloids

During EPA's 2017 recertification, the Agency noted that DOE's microbial colloids parameter did not sufficiently address multiple uncertainties. Both EPA and DOE have worked to address these uncertainties for CRA-2019. *See* Section VI.C.4 of this document for more details.

4. Creep Closure of Open Areas

Creep closure of mined openings in deeply buried salt deposits is a natural process that is certain to occur after WIPP operations cease, but the rate of closure and the final salt properties are uncertain. The exclusion of explicit modeling of creep closure processes for open areas was accepted by EPA in the early WIPP performance models because it eased the computational burden and this exclusion appeared to result in estimates of higher releases by reducing the isolation of individual waste panels. This leads to conservatism in modeling results. However, as a result of the abandonment of the south end of the repository, more open areas will be present with the elimination of panel closures in the south end and the increased size of the operations and experimental areas than postulated in the current 10-panel repository design. Because the characterization of the salt creep closure is still uncertain at WIPP, EPA recommended, in connection with the prior recertification, that DOE improve its understanding of the creep processes and develop a more reliable model in the PA calculation. DOE is investigating the

creep closure process to better understand it for more explicit inclusion in the CRA-2024.[15] Because DOE is still investigating the creep closure process,[16] DOE addressed the creep closure uncertainties in the CRA-2019 by using the interim Abandonment of Panel Closures in the South (APCS) approach (described in Section VI.C.1).

*C. Changes to the Disposal System Identified by DOE for CRA-2019*

In Section 15 of the CRA-2019, DOE identified changes to the disposal system between CRA-2014 and CRA-2019, as well as changes to technical information relevant to §§194.14 and 194.15. Noteworthy changes identified by DOE since CRA-2014 include the following: the decision not to install final panel closures in multiple panels, the abandonment of Panel 9 in the south end of the repository, and the development of the APCS approach to model those abandoned areas; updated borehole drilling rates and plugging patterns; a revised probability of encountering pressurized brine per EPA direction; revised baseline radionuclide solubilities; revised colloid parameters; and inclusion of brine radiolysis in the gas generation model. The addition of six metric tons of surplus Pu to the inventory (Waste Stream SR-KAC-PuOx) led DOE to include gas generation from brine radiolysis, as the concentration of Pu was not high enough during prior recertification applications for gas generation to be a concern in terms of repository performance. *See* both Sections VI.C.5 and VI.F for more discussion.

Before determining that the CRA-2019 was complete, EPA raised technical questions with DOE, as described below. For each topic, a brief summary is provided of how DOE addressed the issue in the 2019 application, followed by EPA's perspective on the change, including any follow-up sensitivity studies conducted by EPA. However, the calculated releases in the CRA-

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[15] DOE Response 6 to EPA CRA19 completeness comment CC3-SCR-3, October 26, 2020, Document ID. No. EPA-HQ-OAR-2019-0534-0017.

[16] Status of Waste Isolation Pilot Plant Rock Mechanics Research, Sandia National Laboratories, May 20, 2020, SAND2020-5269 CTF.

2019 PA were higher than those calculated in the CRA-2014 PA, in part due to the assumptions used in the 2019 PA models to account for abandonment of the southern end of the repository. DOE's approach was intended to bound potential releases, and DOE provided separate calculations to demonstrate that its approach was conservative, tending to estimate higher releases in the CRA-2019 calculations. As in the EPA recertification decision for the 2014 application, in this recertification EPA identifies future analyses DOE will need to conduct in order to address this topic in more detail.

1. Abandonment of Panel Closures and Waste Panel 9

The WIPP repository was closed between February 2014 to January 2017 following an accidental release of radionuclides that contaminated the south end of the underground repository waste area. Access to the contaminated areas was limited for an extended period of time and routine ground control could not be conducted. This resulted in unsafe conditions that led to a DOE decision to seal off and abandon the part of the waste area designated as Panel 9, to cancel the planned installation of run-of-mine salt panel closures in Panels 3, 4, 5 and 6, and to identify the need for a replacement for Panel 9. DOE addressed the impacts of these design changes in the CRA-2019 PA using the APCS approach.

The APCS approach incorporated conservative assumptions that were intended to estimate somewhat higher releases than would be expected given that no waste will actually be in Panel 9. DOE proposed this interim approach for this CRA because 1) DOE had not developed the concept to replace Panel 9 at the time the calculations needed to be started and 2) a long lead time was required to develop replacement models coupled with developing the new design. The primary elements of this approach were to treat abandoned Panel 9 as a surrogate for its replacement (i.e., modeling as though waste had actually been emplaced in the abandoned panel) and to treat the now-empty waste panel access drifts as having relatively high porosities and permeabilities for the 10,000-year EPA regulatory period. In addition, to help ensure that

repository releases would not be underestimated by this approach, the isolation functions of the remaining single panel closures, including the important closures between Panels 9 and 10, were not modeled.

Upon review, EPA found that the assumptions in the APCS approach were not physically realistic but did compensate for inherent uncertainties in modeling the design changes. In accepting the APCS approach, EPA also evaluated DOE's parallel model (CRA19_CL), which assumed all panel access drifts without constructed closures would immediately creep close and have the very low porosity and permeability properties of intact halite.

DOE's model CRA19_CL did calculate lower repository releases compared to DOE's CRA-2019 PA model, but the Agency found that the CRA19_CL model did not address the consolidation and healing of the disturbed rock zones (DRZs) surrounding the empty drifts. EPA separately analyzed the effects of DRZ healing using the Agency's CRA19_COMP model, which modified DOE's model to also treat the DRZs as immediately creep closing to the same properties of intact halite, consistent with the process described previously for the empty drifts (*see* Section VI.E.1 of this document for more detail). The results confirmed that the APCS approach calculated higher repository releases as compared with empty drifts that were assumed to creep close over longer periods to the similar low porosity and permeability endpoints as intact halite.

Additional discussion can be found in the EPA TSD for § 194.23, *Review of the APCS Approach to Analyzing WIPP Repository Performance in the CRA-2019 Performance Assessment* (Docket ID No. EPA-HQ-OAR-2019-0534).

2. Updated Plugging Patterns and Borehole Drilling Rates

***Plugging Patterns.*** As a general matter, and unrelated to WIPP-specific regulations and requirements, before wells are abandoned or permanently closed, various state and Federal regulations require that the boreholes must be plugged and surface equipment removed. Releases

could occur through a borehole that penetrates the waste repository after it has been plugged and abandoned. The depths and stratigraphic horizons of installed plugs (plugging pattern) in abandoned boreholes impact the migration of fluids in and out of the repository, which in turn have significant effects on releases modeled in the PA. If a borehole has one continuous plug, no releases are assumed to occur. Up to CRA-2014, DOE evaluated plugging patterns in boreholes abandoned since 1988 for each CRA based on an updated dataset of the entire New Mexico portion of the Delaware Basin. EPA previously accepted this basis for calculating plugging pattern probabilities.

In CRA-2019, DOE changed the method for calculating plugging pattern probabilities to a narrower one based only on the part of the Delaware Basin within New Mexico's Known Potash Leasing Area (KPLA). DOE justified this change because the WIPP site is within the KPLA boundary, and this area could therefore be considered to represent an appropriate regulatory and geologic analog for future plugging practices at the WIPP. DOE's implementation of this change in the PA contributed to the probability of continuous plug use increasing from 4% in the CRA-2014 PA to 40% in the CRA-2019 PA, based on the field data collected by DOE. This significantly reduced calculated releases. Because this was a major change, EPA paid special attention to the basis for the change.

EPA found that, in the KPLA, boreholes are required to be abandoned with continuous plugs if they are located within known potash reserves, but waivers from this requirement are allowed for boreholes in potash "barren" areas, and waivers to the requirement for continuous plugs are frequently granted in New Mexico. Based on DOE's borehole database, approximately 60% of the boreholes plugged in the KPLA since 1988 did not have continuous plugs installed, presumably due to waivers. In preparing the 1996 CCA, DOE found that the repository is in a "barren" area without economical potash reserves, meaning it would qualify for a waiver. The DOE's CRA-2019 approach does not specifically consider that current law provides for this waiver possibility. Based on current regulations and practices, EPA expects that a borehole

through the WIPP repository would likely be granted a waiver from the continuous plug requirement because it is in a barren area. Therefore, future boreholes through the repository most likely would not be abandoned with a continuous plug and the probability of such a borehole being abandoned with a continuous plug would be much less than the 40% used in the CRA-2019 PA. In addition, the new approach ignores a number of abandoned boreholes directly southeast of WIPP but just outside the KPLA that may otherwise be relevant geological analogs.

EPA concludes that the new approach used by DOE to calculate plugging pattern probabilities is not adequately supported by regulatory considerations or actual practice (e.g., exemptions to the solid plugging requirement) in the KPLA, and it further fails to consider representative, relevant boreholes in the vicinity of WIPP. EPA conducted a sensitivity PA study with the plugging pattern probabilities calculated with the original methodology and the release results show that WIPP still complies (*see* Section VI.E.2 of this document). EPA expects DOE to use the previously approved methodology for calculating plugging pattern probabilities in future PAs, or otherwise propose alternative methods that may be approved by EPA prior to that time.

***Drilling Rates.*** The average areal density (i.e., average over an area) of boreholes drilled in the Delaware Basin in Texas and New Mexico over the past 100 years is called the "drilling rate" in the PA. This rate is used to estimate the number of deep boreholes that might intersect WIPP waste during the 10,000-year post-closure period. Deep borehole intrusion into the repository is the only mechanism for significant releases from the repository, so a greater number of boreholes would increase calculated releases in the PA.

When the drilling rate is recalculated for each CRA, all boreholes without depth information listed at the time are categorized by DOE as shallow "drilling or waiting on paperwork." Noting that, based on historical trends, the majority of boreholes would eventually be categorized as deep, EPA evaluated the impact of this assumption in DOE's methodology. These boreholes will

eventually get incorporated into the PA, but the Agency found the DOE methodology results in additional lag time between when drilling actually occurs and when DOE incorporates it into the deep drilling rate in the PA. The Agency requests that DOE re-evaluate its methodology to better address the lag time between the drilling of boreholes and its capture in the PA for CRA-2024.

A more detailed discussion of EPA's review of DOE's plugging pattern and drilling rate frequency calculations is presented in the EPA TSD *Review of Borehole Drilling Rate and Plugging Pattern Frequency Calculations in the CRA-2019 Performance Assessment* (Docket ID No. EPA-HQ-OAR-2019-0534).

3. Radionuclide Solubilities

The solubilities of actinide elements affect actinide mobilization as dissolved species, microbial colloids, and humic colloids in WIPP brines. The parameters used to represent actinide solubilities were updated in the CRA-2019 PA. EPA reviewed the actinide solubility calculations and identified a number of issues related to the geochemical database and assumptions used to make the solubility calculations, resulting in an underprediction of calculated actinide solubilities (*see* Section VI.D.2 of this document). While these issues did not result in the WIPP exceeding future regulatory release limits, their effects on actinide mobilization in WIPP brines are of concern to EPA and are addressed in detail in Section 7.8 and Attachment B of the EPA TSD *Evaluation of the Compliance Recertification Application (CRA-2019) Actinide Source Term, Gas Generation, Backfill Efficacy, Water Balance, and Culebra Dolomite Distribution Coefficient Values* (Docket ID No. EPA-HQ-OAR-2019-0534).

4. Revised Colloid Parameters

DOE updated microbial colloid parameters based on new laboratory data and changed intrinsic colloid parameters based on a review of existing laboratory data since the previous CRA. Both sets of changes do not reflect the full range of values EPA has seen in DOE's existing data or in the case of microbial colloids, the broader literature. Although there is large

variability in proportionality constants reported in the scientific literature, the variability was not reflected in the CRA-2019 PA microbial colloid proportionality constants since DOE determined these parameters based on a single organism. EPA's review also found that the microbial colloid enhancement parameters used in the CCA provided more defensible and bounding maximum microbial colloid concentrations. Further, EPA found that the parameters for Americium (Am) (III) and Thorium (Th) (IV) intrinsic colloids did not adequately represent the available laboratory data. While these issues will not lead to the WIPP being out of compliance, they are less technically defensible based on the available information. For future PAs, unless DOE proposes an acceptable alternative, DOE should use microbial colloid proportionality constants that adequately address the variability in the literature, CCA-based microbial colloid maximum values, and revised Am(III) and Th(IV) intrinsic colloid parameters that bound laboratory data. Additional discussion of colloid parameters in the CRA-2019 PA can be found in Section 8.3 of the EPA TSD *Evaluation of the Compliance Recertification Application (CRA-2019) Actinide Source Term, Gas Generation, Backfill Efficacy, Water Balance, and Culebra Dolomite Distribution Coefficient Values* (Docket ID No. EPA-HQ-OAR-2019-0534).

5. Inclusion of Brine Radiolysis in the Gas Generation Model

Gas generation from radiolysis of brine in the WIPP repository results primarily from the decay of Am and Pu isotopes. Gas generation is important to repository performance because elevated gas pressure is a driver of the primary release pathways, except for the cuttings and cavings release pathways. An increased mass of Pu projected for disposal in the CRA-2019 waste inventory (Waste Stream SR-KAC-PuOx), as well as a decreased contribution of microbial gas generation to repository gas pressures, prompted DOE to reevaluate the significance of radiolysis to repository performance. Brine radiolysis by Pu in saturated waste was added to the gas generation process model in response to that evaluation and EPA found it to be incorporated appropriately for CRA-2019. However, with the increased importance of Pu in the waste inventory, EPA believes that DOE should continue to refine this set of parameters for the next

PA. Additional discussion of the implementation of radiolytic gas generation and brine consumption in the CRA-2019 PA can be found in Section 3.6 of the EPA TSD *Evaluation of the Compliance Recertification Application (CRA-2019) Actinide Source Term, Gas Generation, Backfill Efficacy, Water Balance, and Culebra Dolomite Distribution Coefficient Values* (Docket ID No. EPA-HQ-OAR-2019-0534).

### *D. Other Issues Identified by EPA During Review*

EPA identified several topics where the Agency believes new information can be incorporated into future CRAs to improve defensibility of the calculated PA results. These topics relate to the chemical conditions within the repository and are important in determining the potential for releases of radionuclides from the disposal system. Although these are important concerns that should be addressed in the future by DOE, for its decision on this CRA, EPA was nonetheless able to adequately evaluate the WIPP's continued compliance with the final disposal regulations and make a sound recertification determination. The following subsections briefly describe each of these topics, and more detail is provided in the EPA TSD *Evaluation of the Compliance Recertification Application (CRA-2019) Actinide Source Term, Gas Generation, Backfill Efficacy, Water Balance, and Culebra Dolomite Distribution Coefficient Values* (Docket ID No. EPA-HQ-OAR-2019-0534).

#### 1. Geochemistry Database

The Agency has identified errors in the geochemical database used to perform actinide solubility calculations for the PA, including errors in DOE's selection of organic ligand stability constants and the inclusion of lead solubility and aqueous speciation data. These errors result in lower predicted releases, especially for the +III actinides. EPA investigated the impacts of database issues in a sensitivity study (*see* Section VI.E of this document for more detail).

#### 2. Initial Assumptions for Solubility Calculations

DOE actinide solubility calculations assumed calcite in brine would precipitate to saturation even though calcite oversaturation (i.e., non-precipitation) is common in low temperature aqueous systems. Although this assumption did not significantly affect releases, the assumption of calcite precipitation also caused significant cement precipitation, consuming up to 83% of water in ERDA-6 brine. These results are unrepresentative of the WIPP system, were not reflected in the rest of the PA, and have important implications towards repository water balance, the availability of radionuclides for transport, the effectiveness of the magnesium oxide barrier used to control carbon dioxide and pH, and on the physical properties of room closure. This is further discussed in Section 7.8 of the EPA TSD *Evaluation of the Compliance Recertification Application (CRA-2019) Actinide Source Term, Gas Generation, Backfill Efficacy, Water Balance, and Culebra Dolomite Distribution Coefficient Values* (Docket ID No. EPA-HQ-OAR-2019-0534).

3. Actinide Solubility Uncertainty

DOE represents uncertainty in actinide solubility by sampling from a distribution that compares modeled solubility to experimental data from multiple reports and peer-reviewed studies. For CRA-2019, DOE used a modified distribution from CRA-2014 which did not include any new studies since the previous recertification. DOE provided an updated distribution following discussions with DOE during EPA's completeness determination process in which the Agency asked the Department to include new data from publicly available literature (e.g., journal articles, government reports) since CRA-2014. EPA's evaluation of DOE's response concluded that the update skewed solubility calculations towards an overly conservative and unrepresentative increase and that DOE's use of the original modified CRA-2014 distribution was sufficient for CRA-2019, even without more recent data. Prior to the next CRA, EPA recommends that DOE perform an evaluation of the relative advantages and disadvantages of other potential approaches for addressing +III and +IV actinide solubility uncertainties to improve confidence in the current approach. This issue and recommendation are discussed in

more detail in Section 7.8 of the EPA TSD *Evaluation of the Compliance Recertification Application (CRA-2019) Actinide Source Term, Gas Generation, Backfill Efficacy, Water Balance, and Culebra Dolomite Distribution Coefficient Values* (Docket ID No. EPA-HQ-OAR-2019-0534).

*E. EPA Sensitivity Studies*

In connection with the prior CRA, EPA identified issues with model parameters and approaches used by DOE and requested that DOE conduct additional calculations so the EPA could better understand how alternative parameter values and approaches would affect repository performance. These calculations were treated as sensitivity studies. To support the EPA assessment of the CRA-2019, EPA conducted modeling calculations to determine the sensitivity of releases to the previously noted issues identified during its review. In combination with other information, the sensitivity studies aided EPA in determining whether the WIPP would continue to comply with the radioactive waste disposal regulations at 40 CFR part 191 and the compliance criteria at 40 CFR part 194. Based on these sensitivity studies, EPA concludes that WIPP continues to comply with EPA's radioactive waste disposal regulatory release limits.

The results from the EPA sensitivity studies are expressed as changes in mean total repository releases in EPA units for comparison with DOE's CRA-2019 results. For reference, the EPA release limits are 1.0 EPA units at the upper probability compliance point of a 0.1 probability of the release and 10.0 EPA units at the lower probability compliance point of a 0.001 probability of the release.

EPA's sensitivity studies examined the technical issues in the CRA-2019 PA that potentially had greater impacts on repository releases. The Agency's modifications to the selected parameters increased calculated releases. However, the total mean releases and the upper 95% confidence limit on those means remained below EPA's WIPP regulatory release limits. The major issues identified in EPA's review primarily influence the importance of the direct brine

release pathway and how the PA simulates those releases. EPA found that direct brine releases are strongly influenced by the degree of waste panel isolation. By treating the now-empty waste panel access drifts in the south end of the repository as retaining high permeability and porosity for the 10,000-year EPA regulatory period and discounting most of the isolation capabilities of the constructed panel seals that remained, the DOE's APCS methodology, described in Section VI.C.1 of this document, did not simulate the isolation of waste panels that is likely to exist. As a result, DOE's use of the APCS methodology in this CRA provided a conservative starting point for evaluating the sensitivity of releases to EPA concerns; that is, the APCS approach calculates higher releases than would be expected to occur. When the previously discussed non-conservative borehole plugging, chemistry, and microbial assumptions in the CRA were removed in EPA's sensitivity studies, the conservatisms of the APCS approach remained. Because of this, EPA believes that the sensitivity study results were influenced by the conservatism of the APCS approach and those results also conservatively estimated repository releases. EPA's CRA19_COMP analysis demonstrated that DOE's use of the APCS methodology in the CRA-2019 PA resulted in greater repository releases compared to modeling approaches that included parameters that assumed less porous and permeable access drifts due to creep closure. EPA's CRA19_COMB analysis subsequently demonstrated that when the cumulative effects of the Agency's parameter changes were added to DOE's CRA-2019 PA releases, total releases remained below regulatory limits.

In the past, DOE has used the previous CRA PA as the point of comparison with the current PA. However, given the issues identified by EPA for this PA, DOE should not use DOE's CRA-2019 assessment as a new baseline for WIPP performance without appropriate adjustments that address EPA's recertification review comments. EPA will work with DOE, as needed, to develop an appropriate model to use for comparisons with future PA calculations.

Summaries of each of the sensitivity studies are provided in the following subsections. More detailed analyses of these studies can be found in Section 4.0 of the EPA TSD *Overview of EPA*

*Review of U.S. Department of Energy 2019 WIPP Compliance Recertification Application Performance Assessment* (Docket ID No. EPA-HQ-OAR-2019-0534).

1. Sensitivity to Creep Closure of Empty Rooms (CRA19_COMP Analysis)

EPA prepared the CRA19_COMP model to study the sensitivity of repository releases to access drift closure and disturbed rock zone (DRZ) healing due to salt creep of empty areas in the WIPP repository. This model supplemented DOE's CRA19_CL model[17] by treating the DRZ as immediately creep closing to the same properties of intact halite as the empty rooms. The results demonstrate that the CRA-2019 PA model using the APCS approach (*see* Section VI.C.1 of this document) calculated greater repository releases than if the empty repository rooms had been treated as fully creep closed to intact halite properties.

2. Sensitivity to Borehole Plugging Frequency (PLG_PROB Analysis)

The sensitivity of calculated repository releases to DOE's new approach to plugging pattern frequency was evaluated by EPA through a comparison of mean total releases calculated by DOE in the CRA-2019 PA, which used DOE's new approach, with mean total releases that would have been calculated in the CRA-2019 PA if the historic approach previously approved by EPA had been used. The results showed that DOE's new approach underestimated repository releases compared to the previous approach. Mean total releases in the PLG_PROB analysis increased from 0.06853 to 0.07924 EPA units at EPA's upper probability compliance point and from 0.7505 to 0.8954 EPA units at EPA's lower probability compliance point. The results of this sensitivity study showed that DOE's new approach materially affected calculated repository releases, though they remained within the regulatory release limits.

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[17] Zeitler, T.R., J. Bethune, S. Brunell, B. Day, D. Kicker, J. Long, and R. Sarathi. 2019. *Summary Report for the 2019 Compliance Recertification Application Performance Assessment (CRA-2019 PA).* 2019. Carlsbad, NM: Sandia National Laboratories. ERMS 571376.

3. Sensitivity to Actinide Solubility (GCHM_S0 Analysis)

The GCHM_S0 calculations inform EPA how sensitive releases are to changes in baseline actinide solubility values. Recalculated baseline solubility values incorporated stability constants from an EPA-updated geochemical database and used changes in initial modeling assumptions about calcite precipitation (*see* Sections VI.D.1 and VI.D.2 of this document). These EPA-recalculated solubilities were verified by DOE in a separate calculation.[18] The resultant solubilities increased both +III and +IV actinide releases. The incorrect values in the database for the Am-, Mg-, and Ca-EDTA constants caused the biggest impact on actinide solubility, underestimating dissolved concentrations by approximately an order of magnitude for the +III actinides. When recalculated solubilities were incorporated into the PA, the results showed increases in direct brine releases and total releases. Mean total releases in the GCHM_S0 analysis increased from 0.06853 to 0.07788 EPA units at the EPA's upper probability compliance point and from 0.7505 to 1.186 EPA units at EPA's lower probability compliance point. EPA expects DOE to update the database and its assumptions regarding calcite precipitation for future PAs.

4. Sensitivity to Actinide Solubility and Colloid Parameters (GCHM_S2 Analysis)

EPA used the GCHM_S2 analysis to evaluate the impact of combining the increase in baseline +III actinide solubility in the GCHM_S0 analysis with updated microbial colloid parameters that are proportional to actinide solubility (*see* Section VI.C.4 of this document). This study also assessed the impact of increased intrinsic colloid values. The results showed that updating the colloid values noticeably increased calculated releases. Mean total releases in the GCHM_S2 analysis increased from 0.06853 to 0.09497 EPA units at EPA's upper probability

[18] Domski, P.S., 2021. EPA Requested Changes to the CRA-2019 DPA Thermodynamic Database and Actinide Solubility Model. December 9, 2021. Sandia National Laboratory. ERMS 576365.

compliance point and from 0.7505 to 1.238 EPA units at EPA's lower probability compliance point.

5. Sensitivity to Actinide Solubility, Colloid Parameters, and Actinide Oxidation State (GCHM_S3 Analysis)

GCHM_S3 is a CRA-2019 PA-based, comprehensive geochemistry sensitivity analysis that combines the impacts of a revised baseline actinide solubility, revised intrinsic and microbial colloid parameters, and revised actinide oxidation state parameters to include only Pu(III), Np(IV), and U(IV) oxidation states in all realizations. The combined chemistry parameter changes resulted in increased direct brine releases at all probabilities and increased total releases at low probabilities. The combined results of these changes showed that the chemical conditions assumed by DOE in the CRA-2019 PA led to lower projected repository releases than GCHM_S3. Mean total releases in the GCHM_S3 analysis increased from 0.06853 to 0.1165 EPA units at EPA's upper probability compliance point and from 0.7505 to 1.516 EPA units at EPA's lower probability compliance point.

6. Sensitivity to Combined Geotechnical and Geochemical Parameter Changes (CRA19_COMB Analysis)

While EPA conducted individual sensitivity analyses that looked at specific changes, the Agency also conducted a sensitivity study that encompassed all changes that EPA determined appropriate to incorporate into a summary PA designated as CRA19_COMB. This sensitivity study was based on the CRA-2019 PA but with the following parameter changes:

- Used the previously established methodology for calculating plugging pattern probabilities (*see* Section VI.C.2 of this document);
- Used revised actinide solubility parameters (*see* Section VI.C.3 of this document);
- Used revised colloid parameters (*see* Section VI.C.4 of this document);

- Used revised actinide oxidation state parameters (*see* Section VI.B.1 of this document).

The cumulative effects of the changes were to increase calculated total mean repository releases from 0.06853 to 0.1669 EPA units at EPA's upper probability compliance point and from 0.7505 to 1.766 EPA units at EPA's lower probability compliance point.

*F. Waste Characterization*

Section 194.24 generally requires DOE to identify, quantify and track the important chemical, radiological and physical components of the waste destined for disposal at the WIPP. DOE collects data from generator sites and compiles the waste inventory on an annual basis. DOE developed the waste inventory used in the PA using data provided in ATWIR (DOE 2018)[19] and PAIR 2018 (Van Soest 2018b).[20] The Comprehensive Inventory Database is used to store and manage all WIPP inventory data and is updated annually using data from the Waste Data System for emplaced WIPP waste, and data from the waste generator sites for anticipated waste.

The Agency evaluated DOE's inventory update process and documentation. EPA also conducted quality assurance (QA) and waste characterization inspections, observations and technical reviews between October 2012 and May 2017 to evaluate compliance with the requirements of 40 CFR 194.8 and 40 CFR 194.24. The Agency finds that DOE has a comprehensive array of QA procedures in place to ensure the accuracy of data published in the annual inventory reports. During EPA site visits, a number of records were reviewed and were found to be consistent with the relevant QA procedures. Based on DOE's inventory updating process, inventory reporting is being conducted in a manner that produces an inventory suitable for use in the PA.

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[19] DOE (U.S. Department of Energy). 2018. *Annual Transuranic Waste Inventory Report – 2018. Revision 0.* U.S. Department of Energy, Carlsbad Field Office, DOE/TRU-18-3425.

[20] Van Soest, G.D. 2018. *Performance Assessment Inventory Report – 2018.* Los Alamos National Laboratory Carlsbad Operations INV-PA-18, Revision 0, December 12, 2018.

The Agency examined the changes in the WIPP inventory since CRA-2014 and compared the CRA-2014 PA and CRA-2019 PA inventories, where appropriate. Changes in the inventory between the CRA-2014 PA and CRA-2019 PA have been adequately explained based on changes in waste stream information. The most significant changes include the addition of Waste Stream SR-KAC-PuOx, which increased the quantity of radioactivity (Pu-239 primarily), and projected waste packaging changes, mainly due to increased remote handled (RH) waste shielded containers, that have increased the amount of packaging steel and lead in the inventory.

The Agency notes that the SR-KAC-PuOx waste stream is composed of Pu oxides that have been downblended using a proprietary adulterant. CRA-2019 does not explicitly discuss the adulterant, but it is included in the calculations as part of the SR-KAC-PuOx waste stream. The downblended Pu waste form will contain, in addition to the Pu, iron-base metal alloys, inorganic materials, other non-ferrous metals, and plastics. EPA staff have been able to review a preliminary DOE report on the waste stream's impacts on repository compliance and conclude that the adulterant should not affect the repository conditions in any unique way for EPA's CRA-2019 recertification decision. Specifically, interactions of this waste stream with the repository will be heavily dominated by its high iron content, which is not expected to alter the expected repository chemical conditions represented in the PA.

The use of all inventory-related parameters in the PA was reviewed by EPA. All inventory-related parameters were correctly implemented in the PA. On the basis of its review, EPA concludes that DOE has appropriate QA procedures in place to accurately document the WIPP waste inventory on an annual basis. EPA further concludes that the PAIR 2018 inventory is appropriate for use in the CRA-2019 PA calculations.

EPA accepts this updated inventory, which is relatively similar to the one used in CRA-2014. These topics are discussed in more detail in TSD for § 194.24: *Review of The Baseline Inventory*

*Used in the Compliance Recertification Application (CRA-2019)* (Docket ID No. EPA-HQ-OAR-2019-0534).

*G. Peer Review*

Section 194.27 requires DOE to conduct peer review evaluations, when warranted, of conceptual models, waste characterization analyses, and a comparative study of engineered barriers. The required peer reviews must be performed in accordance with the Nuclear Regulatory Commission's NUREG-1297, "Peer Review for High-Level Nuclear Waste Repositories," which establishes guidelines for the conduct of a peer review exercise. DOE conducted no peer reviews for inclusion in CRA-2019.

*H. Individual and Groundwater Protection Requirements*

Sections 194.51 through 194.55 implement the individual protection requirements of 40 CFR 191.15 and the groundwater protection requirements of subpart C of 40 CFR part 191. Assessment of the likelihood that the WIPP will meet the individual dose limits and radionuclide concentration limits for groundwater is conducted through a process known as compliance assessment. Compliance assessment uses methods similar to those of performance assessment (for the containment requirements in 40 CFR 191.13 and appendix A) and can be considered a "subset" of performance assessment since it considers only natural (undisturbed) conditions and past or near-future human activities (such as existing boreholes) but does not include the long-term future human activities that are addressed in performance assessment.

In this CRA, DOE updated the data for groundwater quantity determination to define an underground source of drinking water for purposes of calculating groundwater concentrations and doses. DOE used 2016 U.S. Bureau of Census data to update the average number of persons per household to 2.51 and used 2013 data from the New Mexico Office of the State Engineer to update the average household water consumption to 272 gallons per person per day. DOE

concluded that the sub-criterion of 5 gallons per minute rate of production from a well continued to accurately define an underground source of drinking water.

The updates made by DOE in CRA-2019 did not significantly impact the conclusions regarding the groundwater standard in the 1996 CCA. DOE did not change the criteria for making underground source of drinking water determinations. For the CRA-2019 evaluation, the maximum potential dose remained below the CCA calculated value, and DOE concluded that continued compliance with the individual protection standard is maintained. EPA found that DOE is in continued compliance with 40 CFR 194.51 through 194.55 requirements.

## VII. What is EPA's role in future WIPP activities?

EPA's regulatory role at the WIPP does not end with this recertification decision. The Agency's future WIPP activities include recertifications every five years (the next scheduled to be submitted by DOE in March 2024), review of DOE reports on conditions and activities at the WIPP, assessment of waste characterization, quality assurance programs at waste generator sites, announced and unannounced inspections of the WIPP and other facilities and, if necessary, modification, revocation or suspension of the certification.

Although not required by the Administrative Procedure Act, the WIPP LWA, or the WIPP Compliance Criteria, the EPA intends to continue to make all inspection or audit reports and annual reports and other significant documents on conditions and activities at the WIPP, as well as formal communications between the two agencies available in the public docket.

Jonathan Edwards,

Director, Office of Radiation and Indoor Air.

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